Animals as Detectors

Animals in Gas Attacks
Corydon Republican, 4 July 1918

"Poisonous gas having been constituted by our enemies a weapon of war, various scientific authorities have made a thorough study of it on behalf of the Allies. Among other features, the effect of gas attacks upon animals has been carefully noted, the Germans also having studiously investigated the same subject. Results show that horses suffer much from the noxious fumes, and are subsequently thrown into a state of nervous terror on again scenting them. Mules are more inclined to stand their ground, and appear as if trying not to breathe. Gas helmets of a kind have been successfully tried for both these animals. In the trenches are many animals kept by the soldiers as pets. Of these, cats quickly scent the gas, and run about howling. Guinea-pigs are the first to succumb…

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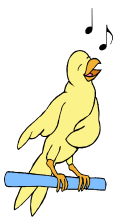
.....Rats and mice emerge from their holes, and are found dead in quantities, which as the soldiers say, is the only advantage of a gas attack by the enemy. Poultry of all kinds are useful for giving warning, ducks and fowl becoming agitated 10 minutes or so before the oncoming gas clouds. Many kinds of wild birds are greatly excited, and the usually unruffled owl becomes, as it were,half demented. Only the sparrow seems to disregard the poisonous vapor, and sparrows chirp on where horses are asphyxiated, and bees, butterflies, caterpillars, ants, and beetles die off in great numbers. The gas at once kills snakes, and earthworms are found dead in their holes many inches below the ground."

Coal Mining

- In the 1700's, certain gases or lack of oxygen were detected with candle flames, which would either go out from lack of oxygen or get larger and change color when certain gases were present; the results were sometimes explosive.

- Canaries proved to be safer detectors. They were taken down into the mines in small cages to signal the alarm when the coal-gas levels got too high. When the birds stopped singing and were observed to be lying feet up, the men got out of the mine.



Iraq, Revisited

- Prior to the onset of operations, the ECBC Operational Toxicology Team received a number of questions about birds, particularly chickens
- A review was done to determine what data were available
- No inhalation data were found for chickens
  - Chickens have been extensively used as a model for OPIDN
    - Another story

Relative Sensitivity of Birds to GB

"Based upon our knowledge of species sensitivity to GB, it would appear that birds are one of the more sensitive species, and their sensitivity may approach that of man. The available data (which are quite old) do not indicate that birds are more sensitive than humans."

Inhalation Toxicity Data for Birds

Species	Agent	Ct (mg min/m^3)	C (mg/m^3)	t (min)	Effect/Comments
canary	GB	33	3.3	10	LCt_{50}; slope = 8.5
pigeon	GA	256	128	2	LCt_{50}
		300	30	10	
		420	0.7	60	
	GB	12.6	216	0.06	
		18	135	0.13	
		25.4	73	0.35	
		37	123	0.3	LCt_{50}; slope = 12
		39	34	1.15	LCt_{50}
		47.5	14.1	3.4	
		48	4.8	10	LCt_{50}; slope = 5.5
		25	25	1	LCt_{50}
		60	6	10	LCt_{50}; 70% dead at end of exposure
	GD	43	4.3		LCt_{50}
	GE	99	9.9		
		256	128	2	
"birds" magpie, jackdaw	GA	20-80	---	10	LCt_{50}
	GB	10-50			
	GD	<50	<5		

The Press

- Chickens and pigeons are being used as sentinels in Iraq because they are more sensitive than humans
  - If this perception is based on the notion that the lethal dose is less than that for a human, it is somewhat flawed

The Facts

- The available data indicate that the LCt_{50} for pigeons is approximately equal to the estimated human LCt_{50}
  - The data do not indicate that the response time for pigeons is particularly rapid
    - Human exposures indicate that the human response time may be more rapid than that of pigeons
- There are no appropriate/relevant chicken data
- Canaries are more sensitive to GB than pigeons
  - However, the limited data for canaries does not indicate that they would be significantly more sensitive than humans

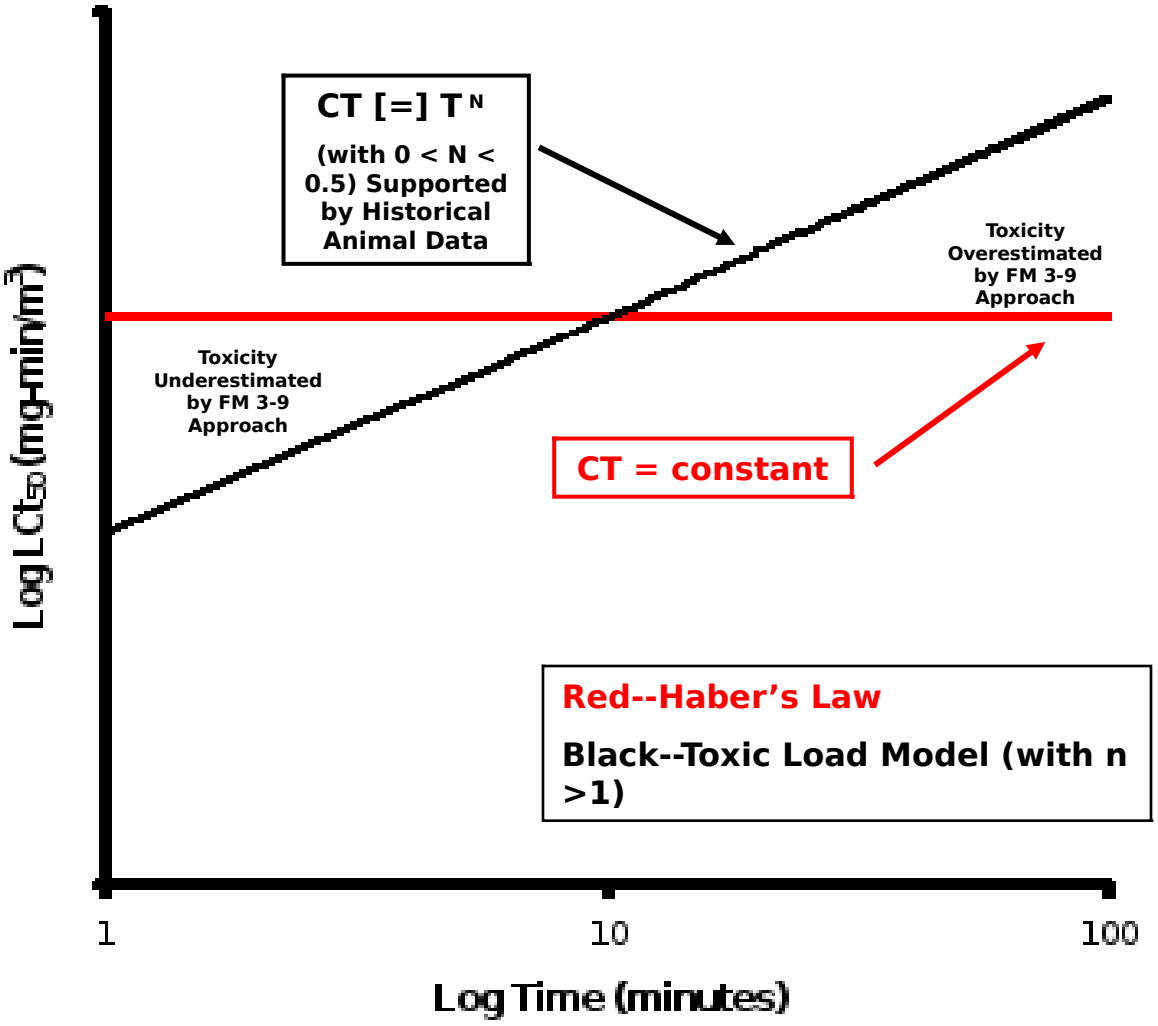
The Facts, *cont.*

- Perhaps
  - The basis for the perception that birds are more sensitive than humans was based upon:
    - 18th and 19th century mining practices
      - Toxic gases were different
    - Previous estimates of the human toxicity of the nerve agents
      - The prior human estimate for the LCt_{50} for humans was 70 mg min/m^3, which is higher than the LCt_{50}s for birds
    - The concept that Ct = k (Haber's rule)

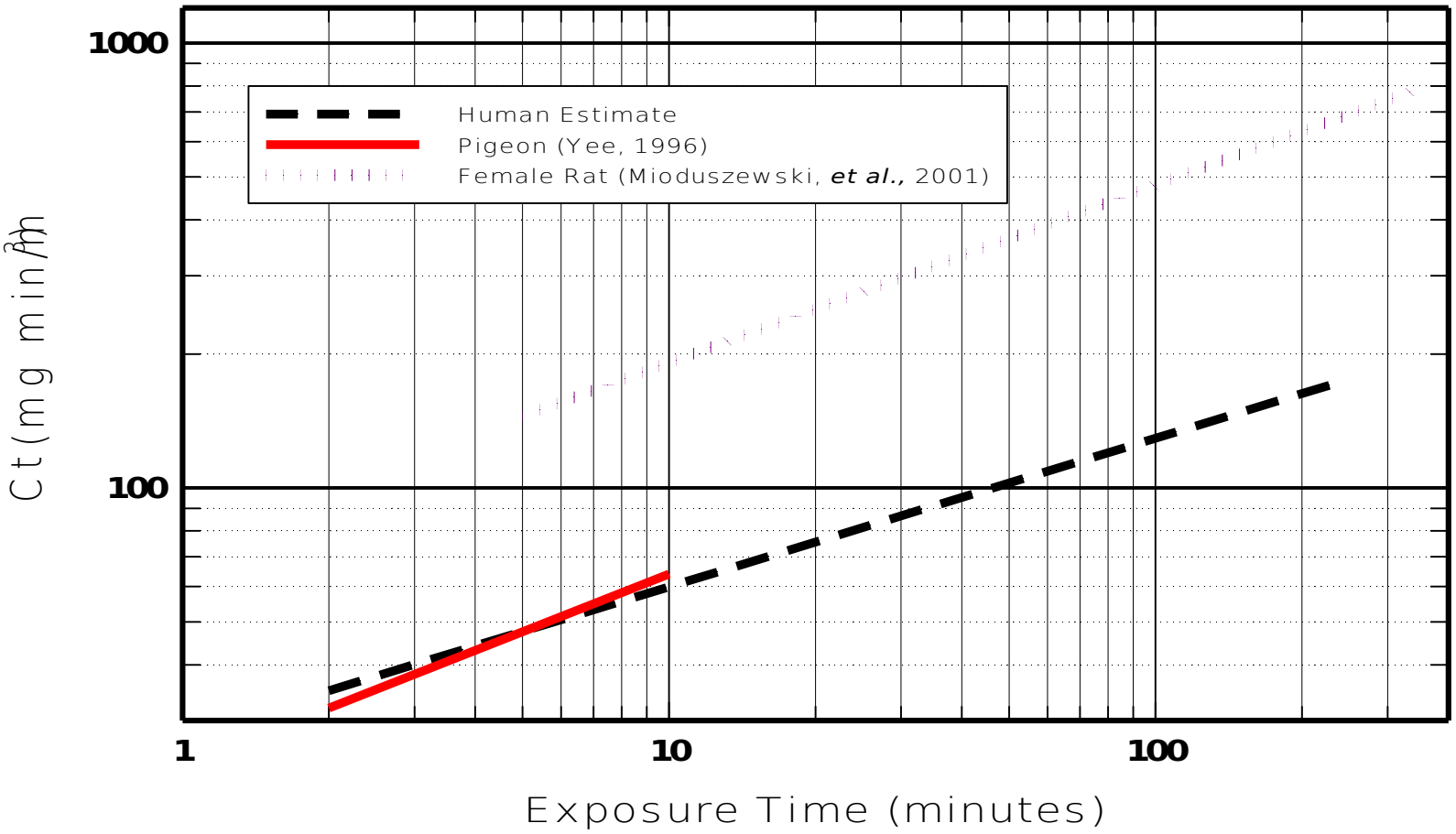
The Facts, *cont.*

- Haber's rule clearly does not apply to the G-agents
  - Comparison of effective dosages must be based upon comparison of equal exposure durations
    - The concentration-time profile for the G-agents is best described by the toxic load model ($C^n t = k$, where $n > 1$) For the G-agents, the effective dosage varies with the agent concentration and the duration of the exposure
      - For a given effect, the dosage for a long exposure to a low concentration is higher than that for a short exposure to a high concentration

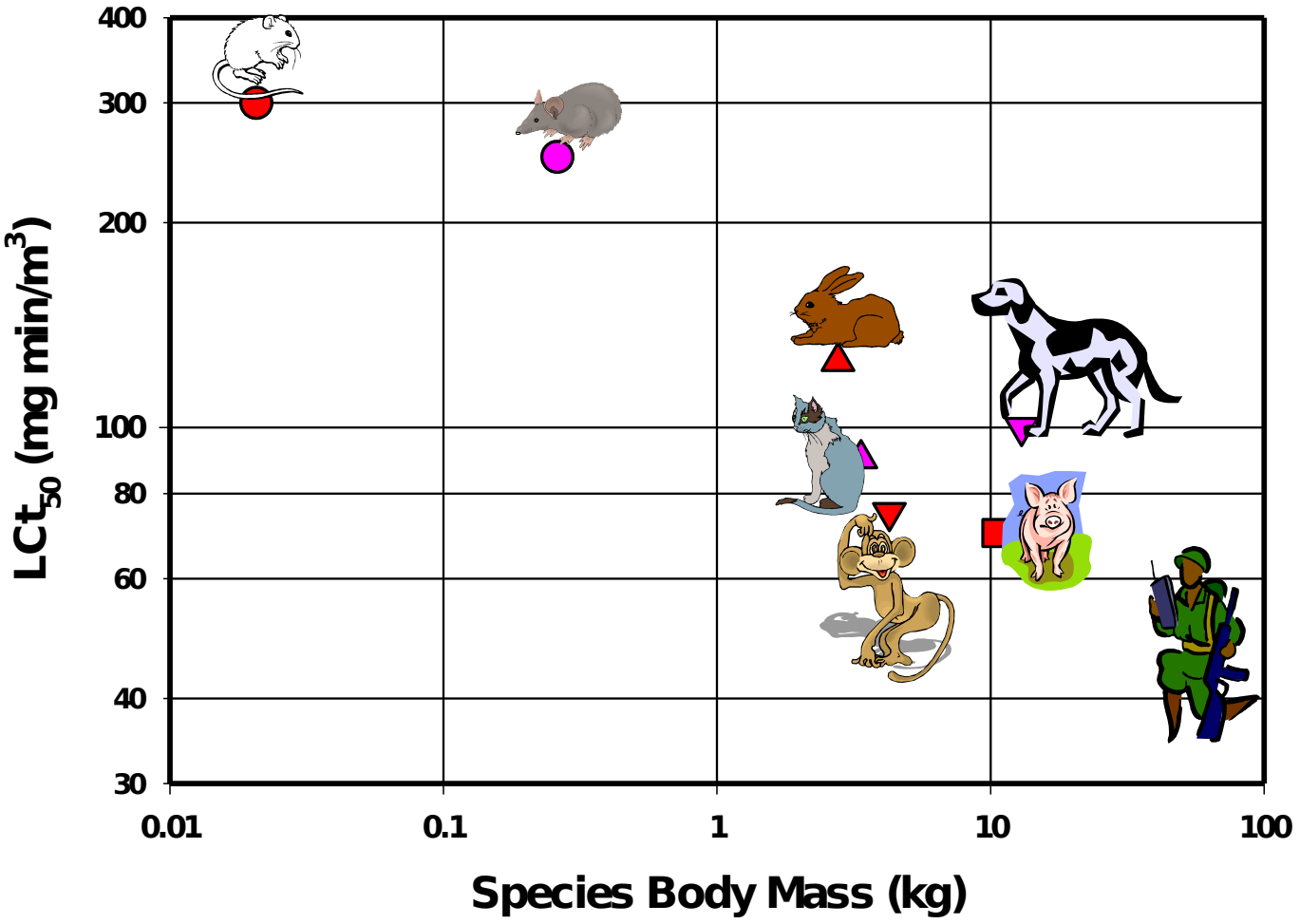
LCt_{50} *vs.* Time



Comparison of GB LCt_{50} Estimates



Body Mass/LCt_{50} Relationship for GB (10-Minute Exposure)



Miosis in Rabbits

- Investigated as a means of detecting GB in a contaminated area
- Rabbit threshold for miosis considerably higher than that for humans
- Time-to-effect rather long
- Humans would have undesirable effects before miosis detected in rabbits

Airborne VX

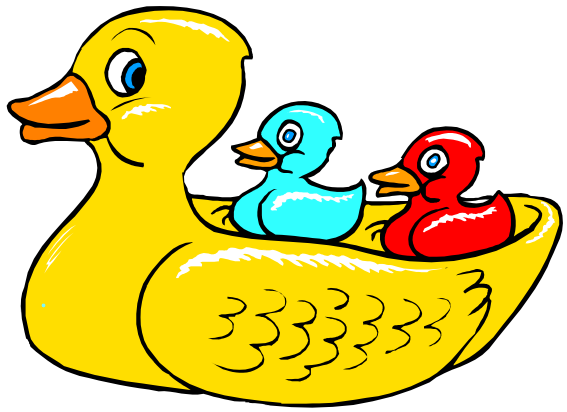
- May follow Haber's law
- Uptake by skin is significant
- Does not follow LCt_{50}/body mass relationship observed for G-agents
  - Body surface area relative to body mass may describe the allometric relationship
- Animals could be as sensitive or more sensitive than humans
  - *e.g.* mice are MORE sensitive than many other species

Other Questions Regarding Animal Toxicity

- "What is the lethal dose for a dog working around HD"
  - Wrong question
- "What dosage of HD will take a dog out of action"
  - Right question
  - Answer:
    - Eye effects; assume dosage is the same as for humans, about 70 mg min/m^3 (follows Haber's Law)—assuming the HD doesn't interfere with the sense of smell at a lower dosage

Housing/Care Requirements

- Strictly regulated—at least in research facilities
  - Type of housing
    - Amount of space
  - Ambient temperature
    - Poultry are extremely sensitive to heat
  - Light cycle
  - Medical care
  - Food
  - Enrichment
    - Toys



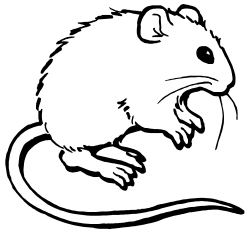
Summary

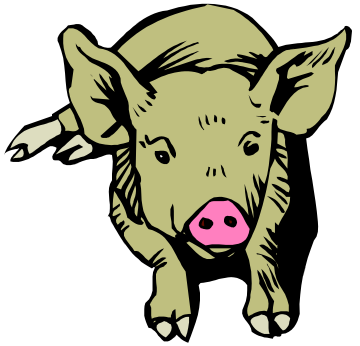
- Based upon the available data:
  - For the G-agents
    - Birds are about as sensitive as humans but are probably not more sensitive
    - There are no small mammals that would be predicted to be as or more sensitive than humans

Summary, *cont.*

- Even if a species were significantly more sensitive than humans, how quickly does it respond to the agent?
  - If the response time is long, it might not be a good detector
- What are the differences between the physiological response(s) in the human and the animal species?
- What is the operational scenario?
  - Under some circumstances animals might be excellent

Summary, *cont.*





- Get the facts